TITLE

STUD WITH HEAT SINK

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from United States Provisional Patent Application Serial No. 60/448,006, filed February 18, 2003.

FIELD OF INVENTION

The invention relates to studs attached to the walls of boiler tubes and furnaces to act as heat conductors or to support refractory concrete and other insulating layers applied to the walls.

DESCRIPTION OF PRIOR ART

Metal studs also known as bolts and anchoring elements are slender metal pieces applied on metal surfaces to provide a means to keep in place on furnace walls different sorts of insulating materials. Insulating media can be applied by hammering, pouring and other means. One of the most common methods of application of such studs is the stud welding process, but studs may be applied by other means such as many different welding processes, thread, clamps and others.

Studs behave as fins in the sense they collect heat from the combustion chamber and allow this heat to flow towards the element to which they are connected. When the equipment is in operation, the stud tip is the most severely affected part of the stud. It is the hottest point, and therefore the tip is the first point in the stud to collapse under high

temperature and other surrounding conditions. Those other conditions could be impact by solid particles of fuel, corrosion or sometimes erosion caused by slag touching the stud. Regardless of what combination of factors act on the stud, the destruction of a stud starts at its tip.

There is a need for a stud having an improved tip that will better resist the conditions that cause the studs to deteriorate. Preferably, the tip will better resist both corrosion and erosion. A stud having such an improved tip will have a longer useful life.

SUMMARY OF THE INVENTION

I provide an improved stud with a serrated tip, which naturally forms a heat sink element at its tip. The serrations can be of any desired shape and pattern but preferably are formed by a grid pattern of cross cuts.

I further prefer to provide a coating on the tip that resists corrosion and erosion. Preferably this coating is a chromium diffusion layer. However, other corrosion resistant and erosion resistant materials could be used. The diffusion layer need not be limited to the tip. Indeed. I prefer that at least the upper portion of the side of the stud also have a diffusion layer.

Other objects and advantages of the invention will become apparent from the description of certain present embodiments shown in the figures.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a perspective view of a present preferred stud.

Figure 2 is a perspective view of a second present preferred stud.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figure 1 a first present preferred stud 1 has a generally cylindrical body having a side 2 that extends from the top 4 to the bottom 8 of the stud. The bottom of the stud may be attached to a furnace wall, boiler wall, boiler tube or a replacement panel for a furnace or boiler. A portion of these surfaces 10 is shown in dotted line. A series of cross-cut grooves 5 are provided in the top which define a series of projections 6 creating a serrated tip. The projections naturally form heat sink elements at the tip of the stud. The serrations can be of any desired shape and pattern but preferably are formed by a grid pattern of cross cuts. The indentations can be made during the cold forming process of manufacturing the studs or can be introduced after the stud is manufactured using roll threading, machining, subsequent cold forming or other techniques. Although the stud is illustrated as having a circular cross-section other shapes including an oval or polygon cross-section could be used. A corrosion resistant coating is applied at least a portion of the stud including the serrated tip. This coating preferably is a chrome layer applied by a diffusion process, such as pack cementation. The coating may contain other elements and combinations commonly used in corrosion resistant coatings to improve corrosion resistance and physical properties. The studs can be any desired length and made of low carbon steel or other metal alloy of the type used for conventional studs. The stud could also be a jacketed stud of the type disclosed in United States Patent No. 5,107,798.

The stud shown in Figure 1, with or without being jacketed, is particularly useful in pulp mill recovery boilers which are particularly corrosive environments. Other applications include waste disposal incinerators which can be of similar construction. In

such incinerators abrasive particles and various solid materials may be directed towards the water tubes. Other examples are oil- or coal-fueled cyclone boilers for power generation, and various types of furnaces used in industrial processes.

A second present preferred embodiment of my stud is shown in Figure 2. This stud 30 has a generally cylindrical body 31 with a series of grooves 33 and ridges 34 extending from the top 35 of the stud. The grooves 33 and ridges 34 do not extend the full length of the stud. There is a smooth section 36 near the bottom 38 of the stud. This smooth section serves as a warning to the user. When the upper portion of the stud has worn down to the smooth section, it is time to replace the stud. The conical bottom 38 of the stud is welded to a furnace wall. The conical shape minimizes the amperage required to weld the stud to a furnace wall. The top 35 of the stud 30 has a series of projections 37. These projections are different in shape from the projections 5 in the embodiment of Figure 1, but they function in the same way. A diffusion coating is applied to the top of the stud. That same coating is also applied to the grooves 33 and ridges 34.

Studs on furnace wall, boiler tubes and furnace panels may be subjected to hot liquids, and/or hot gasses. Solid particles or objects, such as milled coal or fragments of slag or refractory material that have broken loose, may strike the studs. In cases where a stud in accordance with the present invention is exposed to a liquid, the liquid will undergo an effective cooling before it touches the portion of the stud beneath the heat sink elements. In some cases this temperature drop will be sufficient to solidify the liquid in contact with the stud thus providing a frozen layer that insulates the upper portion of the stud from the worst surrounding conditions.

In cases where the stud made in accordance with the present invention is exposed to a gas, the heat transfer to the main portion of that stud (right below the heat sink elements) will be much more uniform than in the prior art studs in which the edges of the stud tip received more heat than all other points forming the tip. The present design equalizes the conditions at the stud tip and will minimize the stresses there. Such stress in studs of the prior art resulted in accelerated wear at the edges of the tip.

There are gaps in the tip of studs made in accordance with the present invention. In cases where the present stud is exposed to impact of solid particles the gaps between the indentations will cause a much higher stress to the incoming solid particles. Generally the higher stress in an impacting particle will break the particle into smaller pieces before the particle hits the surface of the stud below the heat sink. Finer particles of the broken larger particles will be trapped in between the indentations or grooves thus forming an insulating solid layer between the stud tip and the incoming particles.

Summarizing, the stud tips in studs made in accordance with the present invention will usually be insulated against the worse conditions existing in its surrounding due to the interference of the heat sink elements. The serrated surface of the tip together with the coating on the tip give the present stud improved performance and longer life. Without an additional surface enhancement the teeth or indentations would quickly collapse under the intense attack of solids, liquids and gasses that are present in a furnace or boiler.

I prefer that the stud have a layer of anti-abrasion elements and anti-corrosion elements, that have been applied to at least the tip, preferably by diffusion. In the diffusion process the higher the temperature the higher the diffusion rate is. During the

diffusion process, on the tip of the stud will heat more quickly than the remainder of the stud and due to the heat sink effect of the indentation. Consequently, the projections will start absorbing the enhancing elements before all other parts of the stud. During the diffusion process, heat itself will clearly define and at the same time promote the diffusion of the protective elements to the affected parts of the stud.

For this reason, the indentations or grooves at the stud tip will always have a higher diffusion rate than the rest of the stud so that the diffusion coating will be thicker at the tip than on the side of the stud. The heat sink on the tip of the stud assures that diffusion will be more effective in the points more subject to high temperatures when the equipment operates. The diffusion coating layer is always much thicker at the tip. Therefore, the stud made in accordance with the present invention will be more apt to withstand the harsh conditions. Furthermore, such studs minimize the attack to the portion of the stud below the heat sink elements. In experiments run by the applicant, life cycle increases greater than 100% were obtained.

One preferred coating is made using pack cementation deposition. For a chromium coating the pack mix should contain an inert material such as aluminum oxide, a chromium source such as ferrochrome, and an activator such as ammonium chloride. One suitable composition is 55% aluminum oxide, 42% ferrochrome and 3% ammonium chloride.

The diffusion coating is not limited to chromium but could be any material used to provide corrosion resistance, strength or other desired properties. In the particular case of recovery boilers used in the pulp industry better results were achieved by diffusion of chromium only. In the case of cyclone boilers used in the power generation industry

better results were achieved with the co-diffusion of chromium and cobalt or chromium and boron, i.e. one element to enhance the corrosion protection and another to enhance the abrasion resistance. The coating material should be selected according to the combustion products, chemicals or particles to which the studs will be exposed. Suitable coatings could be made from chromium, aluminum, nickel, cobalt, silicon, boron, rhenium, and zinc as well as carbides, nitrides and oxides thereof.

While the preferred embodiments are illustrated as cylindrical studs, the present invention is not so limited. The term stud is here used to encompass any structure that extends from the wall of a furnace or boiler to transfer heat or support a refractory or insulating material. Furthermore, what has been here described as the tip could be an exposed edge of an elongated structure such as a fin or other component found on a furnace wall or boiler wall.

The studs here disclosed may be sold individually or as part of an assembly. That assembly may be an entire furnace or boiler, a boiler wall, a furnace wall, a boiler tube or a replacement panel for a furnace wall or boiler. Typically such assemblies will have a longer service life than a comparable assembly having conventional studs.

Although I have described and illustrated certain present preferred embodiments of my stud with heat sink it is to be distinctly understood that the invention is not limited thereto, but may be variously embodied within the scope of the following claims.